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The Aims and Methods of Science Teaching

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The aims and methods of science are best portrayed in the lives and labors of those masters of science who have lived since the time of Galileo, notably Pasteur and Faraday. These aims and methods are now so generally approved and applied by the teachers of all subjects that the "scientific" method no longer distinguishes the science work from other work in the schools. Science teaching, if it follows the examples of Pasteur, Faraday, etc., may not justly be differentiated from other subjects as materialistic or lacking in cultural or humanitarian elements.

The purpose of science teaching in all grades of schools is not chiefly to impart knowledge of subject matter but to train persons in the method of the masters, which is invariably the *project method.* This is the method used by intelligent men in achieving their ends, in school or out.

A project in characterized in the words of Prof. Mann as follows: "(1) A desire to understand the meaning and use of some fact, phenomenon, or experience. This leads to questions and problems. (2) A conviction that it is worth while and possible to secure an understanding of the thing in question. This causes one to work with an impelling interest. (3) The gathering from experience, books and experiments of the needed information, and the application of this information to answer the question in hand."

A *project,* or *problem,* differs from and is superior to a *topic* in that (1) a project originates in some question, and not in such a logical sequence of ideas as may be found in codified subject matter. In teaching from the so-called "logical" texts one wrongly attempts to induce pupils to accept topics as their own projects. Logical organization of such material as functions in life will be the final result of a protracted study of projects. (2) The project involves the active and motivated participation of the pupil in carrying it out. It does not, therefore, like the topic lend itself to didactic,

formal treatment in which the teacher does all the thinking and the pupil passively absorbs. (3) Projects furnish a basis for the selection of facts according to value or significance, topics furnish no such basis for selection. (4) The project seldom ends in a complete, final or absolutely finished conclusion. It is, therefore, far less likely than is the topic to leave the pupil with the idea that he has heard the last word on the subject. It leaves him open-minded. The project, or problem method of teaching when well done leaves the pupil with a well-organized mass of useful information plus a method of work which will lead him to continue to acquire more. This entire discussion arises from the fact that the logical, topical method has failed to do just this.

Children and adults alike are endowed by nature with the elements of the scientific spirit. The purpose of science teaching is accomplished most successfully when the science classes merely furnish and shape an environment in which the scientific spirit may grow. Under the direction of a teacher who comprehends the workings of the mind, the project method duplicates the methods of active life and thus prepares the pupil for independent thinking.

The present need of the schools is for a large collection of sample projects, or problems, which may be used in showing teachers in a given community how to devise and utilize projects adapted to different grade of pupils in their own environment. The curriculum is the sum of such projects. It must always remain in a state of flux.

A fuller discussion of the project method may be found in the following books and articles:

Science Teaching By Projects
School Science, Vol. 15, pp. 225-232; March, 1915.
General Science and Projects in Science
Teachers College Record, N. Y., Vol. 17, pp. 1-21; Jan., 1916.
General Science and Projects; David Snedden
School and Society, Vol. I, pp. 436-441; March 27, 1915.
Project Teaching; William H. Kilpatrick
General Science Quarterly, Vol. I, pp. 67-72; Jan. 1917.
How We Think—By John Dewey.
Democracy and Education—By John Dewey.
How to Teach—By Strayer and Norsworthy.
A Brief Course in the Teaching Process—By George D. Strayer.
See also Boy Scout Handbook, Doubleday Page & Co., and various manuals on Agricultural Education.

The Aims of Science Teaching and Changing Enrollment

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A comparison of the data given in Inglis's "The Rise of the High School in Massachusetts" with those in the 1916 Reports of the United States Commissioner of Education seems to show that there has been a marked decline in the enrollment of science in Massachusetts in the last fifty or sixty years. The figures which Inglis was able to obtain were rather meagre, though they are from such representative towns as North Hampton, Haverhill, Worcester, Newburyport, Lowell, and Springfield. Those for the last two cities are the more complete, and I give in the following table a comparative statement of the number of pupils taking certain subjects in Lowell, Springfield, and Massachusetts, expressed in terms of the percentage of the total high school enrollment. The data for Massachusetts are taken from the last Report of the United States Commissioned of Education.

Subjects	Lowell Av. per cent. 1849-51	Springfield Av. per cent. 1855-61	Massachusetts Av. per cent. 1914-15
Algebra	22.	34.8	33.99
Geometry	5.	27.5	19.71
Latin	37.	41.9	26.69
Greek	2.5	3.6	1.
French	31.	19.5	39.3
Botany	2.5	11.6	5.8
Chemistry	12.5	13.5	8.78
Natural Philosophy	26.5	16.8	Physics 19.71
Physiology	21.5	23.3	5.55
Physical Geography	18.		4.15
Zoology		17.3	1.32
Household Science		15.7 Dom. Economy	6.56
Bookkeeping	35.5	13.9	8.85

The total percent in science in the Springfield high school in the years given, including Household Science is 129.9 per cent.; in

Lowell, 77.5; in Massachusetts 1914-15, 50.18. There are included in the above tabulation some other subjects in addition to science for comparison.

The total science enrollment in the country, expressed in terms of percentage of total enrollment has decreased in the past five years 5.83 per cent. (1916 Report of the U. S. Commissioner of Education, Vol. II, page 489). Chemistry is the only science which shows an increase; Physics has nearly held its own; Physical Geography and Physiology have had a considerable decline; the proportion in Botany has decreased 44 per cent.; and in Zoology more than 50 per cent. It is true that Agriculture and Biology have gained in some sections of the country very materially, but these gains do not compensate for the losses in the old-line science subjects. It is also true that there has been a more marked decline in certain other groups of subjects, than in science, such for instance, as in the Classics, 11.04 per cent., and Mathematics, 10.37 per cent. of the total enrollment.

It would seem, to use the words of Snedden "that educators generally who look broadly into the field of secondary education must experience a sense of disappointment as to results now achieved through science teaching."* The figures, apparently, are statistical evidence of such disappointment. Snedden believes that the "fundamental difficulty, here as elsewhere in the field of secondary education, is that we have not yet clearly defined the purpose to be kept in view in our teaching."

Certain it is, that there is no unanimity of opinion as to what science is trying to accomplish either in the grades or in the high school. As a result the course in science lacks coherence; there is no dependent continuity. While much of the science teaching is good in a single subject, it is not coordinated with other sciences of the high school, much less with any work that has preceded in the grades.

As a contribution to the survey of the whole field of science work in the public schools, I submit the accompanying tabulation of purposes. Until we come to some general accepted outline of aims, it is relatively useless to undertake a discussion of methods, for the ends we are trying to reach determine largely the methods we shall use to attain them.

* Snedden, David, Problems of Secondary Education, p. 232.

The purpose of science instruction may be tabulated as follows:— The length of the block indicates roughly the proportion of pupils interested in the particular aim; the height, the relative importance of it. The statement of an aim under a definite portion of the school indicates not that it is absolutely confined to such limits but that it is here to be stressed as the most suitable thing for the particular stage of the pupils development.

The Grades	Junior High School	Senior High School	
		The intelligent choice of a vocation and of an avocation, with a knowledge of the fundamental principles of the sciences on which these are based.	**Knowledge of Organized Science**
The establishment of thinking (*i. e.* thinking to conclusion on the basis of observed facts.) (2) a *habit* of scientific thinking (in the development of mind) may be outlined as follows:—	(1) a *habit* of scientific carrying the conclusions The stages in scientific think-	The achievement of a scientific *attitude of mind* as a conscious ideal, to serve as (1) a means of solving life's problems (2) as a stimulus to independent opinions (3) as a basis of wise action. Realize that as an educational process, scientific thinking is incomplete until the conclusions are incorporated in the life of the pupil.	**Habitual Scientific Attitude of Mind**
A. Rendering concepts exact by analyzing things to get at essential likenesses; the "What Stage."			
	B. The problem-seeing, problem-solving type of reaction to environment. Problems are of the concrete type first. How do you do it? How does it work? The "How Stage" Later they are abstract: the "Why Stage" The problem is solved.		
(*a*) By a careful accumulation of facts.	(*b*) By devising hypothesis to explain them.	(*c*) Testing these out by experiment to find the true.	
	C. The application of an already established law to a particular experience.		
Even before the pupil comes to be sufficiently aware of some of the economic scientific problems to shape his actions to meet them it is wise to train him to repair the pump, set up an electric bell, cultivate a garden, raise fruit, care for chickens, etc., in order to give practical skills and to stimulate interest in problems that are involved.			**Practical Skills**
An intellectual and aesthetic appreciation of the commonplace environment. Some appreciation of the achievements of science and of the devoted labors of scientists. A grasp of the moral import of the orderliness of nature and of the pupils obligation to adjust himself to her laws.			**Appreciation**
Acquisition of the habit of healthful personal and community living.	and a knowledge of the facts and principles that underlie such habits.		**Health**

Until the allied sciences come to some general agreement on the objectives to be reached, there can be no concerted action, no plan of campaign that will assure an advance all along the line in science. I conceive that the science teacher is not teaching science for its own sake, at least not until fairly late in the course of study. To test out results only in the terms of the information acquired, is to ignore the accomplishment of the more important ends. Habits and attitudes of mind, as tools of inquiry in settling the problems of individual living and of a democratic society, appreciation and ideals, are the real things to be achieved in public school science, and the organized knowledge of the sciences and the method of science are means to an end.

Aux Morte

enfants de la patrie, qui, tombé sur le champ d'honneur, ont donné à la France une gloire sans pareille.

Vive la France! The bugles blew
To summon men from town and field,
'Neath day's warm sun and night's cold dew
To fight and die, but not to yield,
Staking their lives on War's grim chance!
Vive la France!

Vive la France! They marched away
To stop the huge onrushing wave;
On smoking plain, by forest gray,
They saved their land and found—a grave.
No further shall the Hun advance!
Vive la France!

For them no more the cannonade,
The champaign scorched with liquid fire,
The camp, the trench, the wild parade
Of charging hosts through mirk and mire.
Sleeping, they dream in Death's cold trance,
Vive la France!

The night breeze wanders o'er the plain
Defiled no more by cruel foe;
The ghostly starlight seeks in vain
The valiant dust that sleeps below;
The winds croon where the moonbeams glance,
Vive la France!

But if once more the foe should come
To scourge the land with fire and gore,
To blast of bugle, roll of drum,
These sleeping dead would rise once more
In spirit, seizing sword and lance,
Vive la France!

Vive la France! Strew fadeless bays,
Sons of brave sires, above their dust,
And sing again their Marseillaise
With larger hope and firmer trust!
Toujours la Liberté avance!
Vive la France!

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PART II. COURSES OF STUDY.

The year that has passed since the publication of Part I of this article has been fruitful. The experiences gained have added much in the way of new material and new methods. The ideals, which the science teachers of the Junior High Schools hold, are much the same as they were a year ago but with still greater emphasis placed upon the need of training pupils how to study and to think. We still believe that general science should give the pupils experiences and training which they may immediately apply. We are more than ever convinced of the value of general science for seventh and eighth as well as ninth year pupils. It would be possible to give instance upon instance of the interest manifested by boys and girls in all sorts of science topics that are really related to the home, the school, the street and the community. They are genuinely interested in the every day things. Their interest does not depend upon science of a spectacular or unusual nature.

It is too early, perhaps, at this time to judge accurately as to the value of this general science in its relation to later high school science but it is not too much to say that the majority of the pupils have acquired an alertness, a power of observation and a pleasure in science that will play a significant part in their later work. That they have received a large amount of useful information and have been awakened to the reality and the beauty of nature is certain. Many of them have evidenced real acuteness of thought and have attained unexpected ability in scientific study and methods. The past year's study of the problem, together with former experiences in general science, has confirmed our conviction that general science should in no sense be considered a "try-out" course for boys and girls to enable them to select for later intensive study any of the special sciences. It is true that some of our pupils have shown an aptness for some of the special sciences which we shall endeavor to foster as they go on into high school, but we believe that general

science should have for its major aims the study of the immediate surroundings of the child, the betterment of his health and his mind.

As a result of two years work it seems best to place general science in the seventh, eighth and ninth years, whereas in the beginning the science work of the eighth year was limited to hygiene, organized as a part of the physical training. Likewise a ninety minute period for science work for the seventh grade pupils has proved excessive in length. A resourceful teacher can hold the attention and interest of the children this length of time for a day or a few days in succession but no teacher can be expected to obtain the best results that science teaching offers the opportunity for, if she must exert herself continuously day after day with 90 minutes for each class. Both teacher and pupils tire. Neither does it seem possible to devise any sort of laboratory or busy work which of itself holds the interest and eagerness of a seventh year child for a long period. Hence at present, our time schedule is as follows: Two forty-five minute periods per week throughout the entire year for pupils in the seventh and eighth grades and three ninety minute periods per week throughout the entire year for ninth year pupils.

Experience has taught something along the line of class trips. We have concluded that with a large class of boys and girls short trips of 15 to 30 minutes, in the vicinity of the school are more productive than the extended trips. Every class takes a number of these outdoor excursions, each excursion having a very definite and at the same time limited object in view. As the observations to be made on any one trip increase in complexity so is the clearness of the child's vision dimmed and the value of the trip lessened, particularly is this true for the seventh and eighth year pupils. Most of our more extended trips are organized on the basis of delegates chosen by the class groups to represent them. These delegates are told before hand what particular thing they are to be responsible for on the excursion as a whole. For example, if there are five ninth grade classes, and four delegates are selected to represent each class in a visit to a modern creamery, the creamery operations would be divided into four processes or groups of processes, and one delegate from each class would be made responsible to report in detail about his particular process to his class. A group of twenty boys and girls is about all one teacher can see to adequately on a trip to a commercial institution. This plan has the disadvantage, to be sure, that some of the pupils do not see some of the commercial

processes. This is made up for in part by allowing members, other than the elected delegates, to attend the trips by special permission. This scheme has the very marked advantage of eliminating certain pupils who are sure to be uninterested and mischievous and one or two such persons on an excursion will prove a considerable handicap. It should be understood that wherever and whenever it is practicable the entire membership of the classes are taken on excursions, especially is this true of outdoor excursions and to some commercial establishments.

The observation bulletin referred to in the previous article has grown in importance. To send a pupil out into the byways to make a particular observation and to report thereon, insisting upon accuracy both of the observation and of the report has proven of genuine value. This observational work admits of an unusual amount of individuality and often gives the teacher an insight into the pupils interest quicker than any other part of the work.

The added experience has deepened our conviction that the so-called individual laboratory experiments are to a large extent unsuited to seventh and eighth grade pupils and are only slightly more suitable to the ninth year pupils. The average seventh and eighth grade pupil will make play of the individual experiment and fail to reap the benefit hoped for, whereas in the "group experiment" each child is made to feel his responsibility toward the others of his group and toward the rest of the class, to whom he must report, and is likely to do his part well. Demonstrations by the teacher have been reduced to a minimum. Demonstration work of all sort is done by the better, more skilful pupils. This activity which is allotted only to the most careful pupils serves as a stimulus to many in the class to excel their neighbor.

We have done away entirely with the set laboratory period. Every science teacher has undoubtedly felt the impossibility of keeping class work and laboratory work going hand in hand under the plan of special laboratory days. In the Junior High School all of our work may be considered laboratory work inasmuch as the pupils must record in note books data on the problem at hand collected from so-called laboratory work itself. To this is added data collected at home or on the street and data obtained from the study of books pertaining to the subject. This means that the text-book study of the pupil is devoted at once to a purpose. Instead of studying to learn or memorize what a certain author has thought

wise to tell about a topic, our boys and girls study a text book to get information which will enable them to solve a problem. As far as possible formality in the writing of notebook reports is reduced to a minimum since formality necessarily hampers individuality. For the convenience of the teacher in inspecting the note books, and at the same time to teach the pupil the value of note book methods, some small amount of formality seems necessary. The pupil is made to feel the value of indicating in his note book, information which he obtains second hand from a fellow observer or from a text book or from his teacher. He is asked to indentify or distinguish plainly this sort of material from the data which be obtains as an individual and which to him has all the attributes of real discovery. In this way and by requiring adherence to accuracy we endeavor to keep the value of truth always in the foreground.

At the end of this article will be found a brief but suggestive outline of the topics used as a guide in our science work in the Junior High School. It must be kept in mind that these topics are not considered final. Any outline of topics for a course in any science should be considered by the reader from the standpoint of the pupils whom it is to serve. Any outline, at best, is a poor substitute for the details as worked out in the class itself. The outline of topics which follows is intended to give the reader an idea of the viewpoint from which we try to present the subject matter as well as topics covered. The subject matter itself must, in all cases be adapted to the mental development of the child.

It will be noticed that the work is not divided in any sense into short courses of the various special sciences. To find the physics or the chemistry or the biology one must follow the workings of the development of the topic. For example, there is a considerable amount of hygiene given under the cover of every topic in the outline. Some topics of the physical sciences are worked out in the development of the study of foods and the study of ventilation and illumination of houses, etc. Some teachers will at once wonder at the absence of topics on electricity. The writer and his co-workers feel that electricity such as can be taught in the ninth year partakes almost entirely of the nature of play and this same playwork can as well be done by sixth grade pupils. It is our conviction that topics of electricity are more suitable for later high school study.

This same outline of topics is used by the Household Arts pupils for a portion of their science work and also by the pupils of the

Industrial Arts Courses. Too often teachers lose sight of the fact that the boy who is being given training for shop work to be taken up as soon as he leaves elementary school, needs perhaps more than all other students to have his senses made alert to the beauties of nature, to have his eyes opened to the things about him which otherwise he is so likely to miss when he gets into the shop. The more likely it is that boys or girls in their life work may be tied up indoors at the bench or the machine or the desk, so in the same proportion is it incumbent upon us as teachers to give them the inspiration needed that will draw them out of the shop, out of the store and out of the house into the open. The particular emphasis of a topic, as taught to boys and girls who plan later high school work, may not be at all the proper emphasis for the boy who plans to spend his energies in the shop or the manufacturing plant. Therefore we vary the emphasis and the application depending upon whether the boy or girl is in the Household Arts Course, the Industrial Arts Course or the Academic and Commercial Courses leading into the high school. All of these boys and girls irrespective of their later life interest and vocation should be given the same opportunity for training that makes for better health and happiness and appreciation of nature throughout their life. They should be given the same opportunity for mental and moral education, and that science lends itself particularly to these purposes is evident.

Now, as at no other time in educational history, is it necessary that we teach conservation—of fuels, of foods, of health and of time. We must eliminate the waste from our work so that we may do the most for our pupils in the shortest possible time. Now if ever must the science teacher train the child for democracy, and set up democratic ideals by example and precept. General science opens wide the doors of opportunity in this time of need, and worthy of the name is that teacher who enters, hand in hand with his pupils.

In the general science courses a fair balance between biological sciences on the one hand and physical and geographical science on the other is maintained although the work is not separated into the special sciences. The pupil's work is definitely mapped out for him and concentrated, productive effort is required at all times. The attempt is made:

1. To develop powers of observation and awareness of surroundings, and so add to the pupil's experiences.
2. To help the pupil gain simple accurate concepts.

3. To help the pupils to an understanding of the common phenomena of their immediate environment.
4. To train the pupils to be able to apply experiences and concepts acquired to the solution of new problems.
5. To train the pupils in the science method of procedure and study.
6. To establish an habitual scientific attitude.

The methods used include supervised study, laboratory work, demonstration, recitation and excursion, (individual and group).

The topics for study are arranged in groups and the information and training obtained by study of any group is made to play a definite part in the study of succeeding groups. The arrangement of groups is somewhat determined by seasonal changes. The arrangement of topics within a group is either psychological or logical as the particular case demands.

Directed outdoor and home observations are carried on by all pupils. Oral or written reports are made out on all observations and inferences drawn therefrom.

The science work is made to serve as a vehicle for moral instruction whereever it is suitable.

Throughout all courses the home, street, school and city environment as contributing to the physical, mental and moral development of the pupil is made the keynote of the science study.

Individual pupils are encouraged to continue, as special problems, the particular line of science that seems to interest them most or for which they seem best suited, with the hope of keeping their particular interest alive until it can bear fruit.

Pupils are urged to continue their special interests or hobbies through the medium of Science Club Organizations.

General science is required of 7th and 8th grade pupils. The time for this work is 2 periods (45 minutes each) per week for the school year.

7 A and 8th grade Household Arts and Industrial Arts pupils are given work especially adapted to their special needs.

General science in these grades is correlated with the work in history, civics and geography.

General science is required in the 9th grade. The time for this work is 3 periods (90 minutes each) per week for the year.

In the Academic and Commercial courses biological science as interpreting the health and hygienic needs and habits of adoles-

cence, civic sanitation and the pupil's environment forms the keynote. Much use is made of the helpful parts of the special sciences particularly as applied to milk and water supplies, heating and ventilating, illumination, household mechanics, foods and nutrition, growth and disease of plants, etc. The course is not at all divided by lines that mark the usual boundaries of those special sciences.

The science for the Household Arts and the Industrial Arts pupils is planned so as to emphasize their special needs.

The Household Arts pupils require considerable work in food chemistry while the Industrial Arts pupils need more intensive work in physical science as applied to machines and shop practice.

Outline of General Science Courses.

7 B and 7 A Grades.

Fall Term:

Rocks:

1. Rocks as building stones.
   Limestones, sandstones, marble, granite.
2. Rocks and minerals.
3. Rocks as soil producers.

Soil:

1. Formation of soil.
2. Soil in relation to plant life.

Rivers:

1. Rivers as soil makers.
2. Rivers as soil distributors.
3. Rivers and flood control.
4. Rivers as a means of transportation.
5. Rivers as a source of power for industries.
6. Rivers for beauty and health.

Observational work:

1. Bird life, (one or two special birds).
2. Cocoons.
3. Spiders.
4. One familiar tree (maple, elm, etc.)
5. Seed dispersal.
6. Frequent outdoor temperature readings.
7. Observation of wind direction.
8. The "North Star", "The Big Dipper."

9. The equinox.
10. Conservation as applied to: *a.* Soil fertility; *b.* water power; *c.* forests; *d.* birds.

Spring Term:

Air:

1. What air does. Combustion. Oxidation.
2. What is good air?
3. Good air and health.
4. Hygiene of breathing.
5. Good air and proper breathing a means of disease control.

Fire:

1. Feared and worshiped by man.
2. Uses of fire.
3. Loss by fire.
4. Fire prevention measures.

Observational Work:

Special Days.

1. Arbor day.
2. Bird day.
3. Clean up week.

General:

Bird study.
Temperature readings.
Wind direction.
Planets—"Morning and Evening Stars".
Continue tree observations,
Branching, budding, flowers, leaves.
Home garden planning.
School garden planning.
Conservation as applied to: *a.* Health; *b.* Fuels; *c.* Building material.

8 B AND 8 A GRADES.

Fall Term.

Personal Hygiene:

1. Kinds of soap and how they are made.
2. How soap cleanses.
3. Use of soap in the laundry,
Removal of stains.

4. Substitutes for soap.
5. Soap and a clean skin—a clean skin and the health.
6. Tooth paste and powders—hygiene of the teeth and mouth.

Community Sanitation:

1. Garbage disposal.
   a. Recepticles for garbage. Kind. Care.
   b. Prevention of flies and odors.
   c. Collection of garbage. Methods. Efficiency.
   d. Method of sewer disposal. Saving the fats.
   e. Rochester plan.
2. Sewage disposal.
   a. Sanitary plumbing. Care. Use.
   b. City sewers.
   c. Rochester plan.
   d. Other plans.

The Heavens:

1. The Earth and her moon.
   a. Location of places on the earth.
      Latitude and longitude.
   b. The motions of the earth and their effects.
   c. Time on the earth.
2. Our sun and his family of planets.
3. The stars and constellations.
4. Archimedes, Galileo, Newton.

Observational Work:

1. The winter birds and their entertainment.
2. Frosts and their effect.
3. The study of a special tree—a shrub.
4. Wind direction and velocity.
5. Air temperature—observations.
6. Planets and constellations.
7. Seeds and seed dispersal.
8. Grasshoppers.
9. Conservation as applied to: *a*. Foods; *b*. Crops—seeds; *c*. Birds.

8 B and 8 A Grades.

Spring Term:

The Weather:

1. Weather, likes and dislikes.
2. Sayings about the weather.

3. Weather factors.
   a. Temperature—Thermometer and its use.
   b. Winds—Direction, velocity, cause.
   c. Air pressure—Relation to storms; How to measure.
   d. Humidity and Health.
   e. Precipitation—Clouds, rain, snow, dew, frost.
4. Climate in relation to crops, industries, health.
5. Weather Predictions.
   a. Pupil's prediction based upon personal observation of weather factors.
   b. U. S. Weather Bureau predictions—value.

Water:

1. Its occurrence in nature.
2. Properties, impurities and use of water.
3. The local water supply.
   a. The home Water Works.—Faucets, Water pipes, Meters.
   b. The city reservoir and distributing conduits.
   c. The lake sources—Their altitude and results; Sanitary control of shores and drainage area.
   d. Local needs and methods for purification—Home treatment—boiling.
4. Purification methods of other cities.
5. Vacation dangers in drinking water.
6. Chemically pure water—distillation.
   Application of process of distillation.—Gasoline, Benzine, Kerosene, Lubricating oils, Alcohols.

Gardening:

1. Preparation of soil.
2. Planting.
3. Care of plants.

Observation Work:

1. Daily weather observations.
2. Bird life.
3. Flies, mosquitoes.
4. Fire risks.
5. Tree study—branching, budding, etc.
6. Conservation as applied to: *a.* Drinking water supply; *b.* Fuels—gasoline, kerosene, alcohol; *c.* Health.

Fall Term:

Animal Helpers:

1. Birds vs. insects.
2. Toads *vs.* insects.
3. The economic importance of the earth worm.
4. Fish.
5. The cow and the horse.

Efficient Man:

A. Food Studies.
   1. Preparation of food.
   2. Foods and diet.—How the body utilizes foods to produce greatest efficiency of body functions, digestion, circulation, etc.
   3. Pure foods and drugs.
   4. Grocery sanitation.
   5. Kitchen sanitation.—Saving food from the garbage pail.
   6. Nutrition aids.
   7. Nutrition handicaps.

B. Good air studies.
   1. What is good air?
   2. How to obtain good air.—Ventilating and heating: *a.* Home; *b.* School; *c.* Shop; *d.* Store.
   3. How the body uses the air.
      a. The lungs.—Function, Care.
      b. The skin.—Cleanliness vs. function.
      c. Posture and exercise.
      d. Respiration and disease.

C. Studies of body wastes.

D. The nerve control.
   1. Automatic. 2. Voluntary.

E. Illumination and color.
   1. Home, school and shop lighting.
   2. Wall paper and colors.
   3. Good eyesight an asset.
   4. Poor eyesight a handicap—its correction.
   5. Prevention of blindness.

F. Personal Hygiene.
   1. Hair. 2. Nails. 3. Skin. 4. Clothing. 5. Shoes, etc.

Observational Work:

1. Birds, insects, toads.
2. Seeds and seed dispersal.

3. Fall planning for gardens.
4. Weeds.
5. Tree study.
6. Amateur weather forecast contests.
7. Conservation as applied to: *a.* Insects; *b.* Birds; *c.* Animals; *d.* Foods; *e.* Health.

Spring Term:

Germs:

1. The smallest plant and animals.
   A. How they hinder man.
   B. How they help man.
2. Plant diseases. Animal diseases.
3. Germs, yeasts and molds as related to the preservation of fruits and vegetables.
4. Prevention and control of disease.
   Immunization.
   Vaccination.—Smallpox, Diptheria, Whooping Cough, Typhoid fever.
   Eradication.—Antiseptics, Disinfectants, Pasteurization, Sterilization.
   Elimination of carriers.
   Personal hygiene.
   Public hygiene and sanitation.

Milk:

1. Milk, its food value.
2. Clean vs. dirty milk.
3. Pasteurized vs. raw milk.
4. Problems of the production, transfer and distribution of clean, wholesome milk.
5. Utilization of unused milk.
6. Proper care of milk in the home.
7. Danger of disease distribution in milk and its control.
8. Civic hygiene as related to milk.

Plants:

1. Our dependence upon plants.
2. Proper conditions for the growth of plants.
3. Plants in relation to food, shelter and clothing.
4. Care of plants—cultivation, watering, spraying, propagation.
5. Planning a garden.
6. Weeds.—Their control.

General Science in Michigan

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The subject of general science has been discussed throughout the country for the past five or six years. Its aims, advantages, place in the curriculum, content and method have been the subject of articles in educational magazines; committee reports have been published on it and science conferences have considered it from all angles. Surveys have been made of general science in other states; this report is made so that the status of general science in Michigan may be known.

The data which is the basis of this report was received from answers to a questionnaire which was sent to the high school science instructors in the schools on the 1916 accredited list of the University of Michigan. Accredited schools were chosen because they, it is assumed, are representative of Michigan schools; and furthermore, they are the schools that are interested in university recognition for general science. As the questionnaires were answered in the fall of 1916, this report deals with the conditions of general science for the first semester of the school year 1916-17. One hundred and seventy-two of the two hundred and eighty-three schools on the list replied.

When answering the question, "Is a course in elementary or general science offered?" instructors were asked to distinguish between elementary and general science according to the distinction made by Prof. E. D. Huntington of the Western Normal of Michigan as given in his Discussion of the Report on the Elementary Science Situation in Michigan, printed in the Journal of the Michigan Schoolmasters' Club, 1916.

"The essential difference between elementary and general science is that the former would present the elements of certain specialized sciences to the child from the standpoint of the sciences, while general science would select facts and principles from the whole field of science according to the needs of the ninth grade child and endeavor to present this subject matter to the child by such methods as will arouse and hold his interest."

In case neither such course was offered, the question was to be

answered—neither. Below are the answers to the question quoted above together with the data received from the question, "If no general science course was at present offered, is it your plan to do so soon?"

Having elementary science	7 replies
Having general science	69 replies
Having neither	96 replies
Planning to offer it soon	36 replies

The distribution of schools according to high school enrollment furnishing the above data is given below:

Enrollment	*Elementary*	*General*	*Soon*	*Neither*
Under 100	2	14	10	40
100-200	4	30	18	32
200-300	1	13	4	8
300-400		4	2	7
400-500		2	1	4
500-600		1		
600-700		2		
700-800			1	1
800-900				
900-1,000				1
Over 1,000		3		3

In order to facilitate discussion, elementary science will be considered under the head of general science during the remainder of this report.

Our data show that:

I. At least 27% of the 283 accredited schools offer general science.

II. At least 22% of the entire number of high schools in Michigan, 345 in number, offer general science.

III. One half of the schools offering general science are in the North Central Association of Colleges and Secondary Schools.

IV. Assuming that the schools answering "soon" carry out their plans, in the near future, 112 or at least 39% of the accredited schools will be offering the course. Three schools are offering the course for the first time during the second semester of the year 1916-17.

Two instructors volunteered the information that they were offering no such course "because the university does not recognize

it." Five schools report that "we will offer it as soon as it is recognized."

The data from the questions, "In what grade is general science offered?" and "What is the length in years?" are tabulated below:

Grade	Length of Course	Occurrence
9	1 year	40 schools
9	½ "	6 "
9-10	1 "	3 "
9-10	½ "	1 "
9-12	1 "	2 "
10	1 "	3 "
8-9	1 "	3 "
8-9	½ "	1 "
8	1 "	9 "
8	½ "	1 "
7-8	2 "	4 "
7-8-9	3 "	3 "

The above table shows that, as regards to position in the curriculum:

21 courses are below the ninth grade.
59 courses are in the ninth grade.
9 courses are above the ninth grade.

Where the course is in the high school, 51 are 1 year courses and 8 are one-half year courses.

Where the course is below the high school, 15 are 1 year courses, 2 are one-half year courses, 4 are 2 year courses, and 3 are 3 year courses.

In the above three tables, the courses that were offered both in the ninth grade and below were treated as separated courses, as were those appearing both in the ninth grade and above. This explains the discrepancy of more schools answering the question quoted above than the number, 76, that actually have the course.

Two schools, Scottville and Munising, (enrollments 175 and 125 resp.) reported themselves as being on the 6-6 plan (six years elementary school and six years high school). The Scottville course in general science is arranged thus:

Grade 7—elective, reciting 2 forty-five minute periods per week.
Grade 8—elective, reciting 3 forty-five minute periods per week.

Munising reports:

Grade 8—compulsory, reciting 5 forty-five minute periods per week.

Kalamazoo reports 6 schools offering general science, 3 of these have a junior high school of 7, 8 and 9th grades and offering it in each grade. In these schools, the course is distributed thus:

Grade 7—required, reciting 2 forty-five minute periods per week.

Grade 8—elective, reciting 4 forty-five minute periods per week.

Grade 9—elective, reciting 5 forty-five minute periods per week.

In the other three schools, the course is distributed as in the 7th and 8th grades above.

Muskegon (enrollment 1250) reports one 5 year high school. General science is offered in the 8th grade and is continued as organic physiology in the 9th, being compulsory in both grades.

Grand Rapids Central High school (enrollment 1200) reports an elective course offered in 8b and 9a and continued in 9b as physiology, the course being one or three semesters in length.

The answers to the question, "What other sciences are taught in the school, and in what years?", taken from the schools that answered as having general science, are tabulated below. Only high school subjects are considered.

Science	*9*	*10*	*11*	*12*	*Total*
General Science	57	9	2	2	70
Botany	18	32	1		51
Physiography	4	14	2	1	21
Zoology	1	13	1		15
Biology	5	11	1	1	18
Agriculture	2	8	13	7	30
Physiology	2	8			10
Physical Geography	3	4	1		8
Horticulture		1	1	1	3
Greenhouse and Garden Practice		1	1	1	3
Geology			1		1
Chemistry			54	17	71
Physics			17	54	71
Hygiene				2	2
No Course		5	1		6

In addition to the 70 courses of high school general science, there are 2 in the seventh grade and 17 in the eighth grade.

The table should be read: General science is given in the ninth grade in 57 schools, in the 10th grade in 9 etc.—similarly for other

subjects. Many schools offer the same course during different years; such is the case with horticulture and greenhouse and garden practice; 2 schools offer agriculture in each of the high school years. Five offer it for three years and three for two years. The largest number of science courses offered in one year in any school is four. General science is the dominant subject in the ninth grade; botany in the tenth grade; chemistry in the eleventh grade; physics in the twelfth grade. There are as many twelfth grade chemistry courses as there are eleventh grade physics courses. The poor showing of physiography is due to the fact that it is superseded 28 times by general science. We notice that general science ranks third in the high school science curriculum; that it is offered one-fifth as many times as all the high school sciences; and that it occurs three times as often an any other ninth grade science.

The aims and purposes for the course "that have been formulated in order to justify it to school constituencies and pupils", are divided as follows: The number following denote the number of times it was mentioned—some instructors having more than one aim for the course.

I. General science lays the foundation for future science courses—47.
   - Stimulates interest in science—15
   - Enables pupils to choose intelligently science courses in the future—8.
   - Embraces all science—1.
   - Teaches diction of science—1.
   - Introduces scientific methods—6.
   - Good introductory course to specialized science—11.
   - Shows interrelation between sciences—1.
   - Removes dread of later sciences—1.

II. General science explains the pupils' environment—31.
   - Pupils can understand interests in town that depend on science—4.
   - It gives an understanding of everyday phenomena—10.
   - Students can appreciate the beauties of nature—1.
   - Teaches everyday life—10.
   - Student will find that he can discover things for himself—1.
   - It is more practical than physiography—1.
   - Gives general information—is cultural—3.
   - Pupils will be able to understand scientific papers—1.

III. Those people who do not elect the specialized science courses later or who drop out of high school will nevertheless have some science—19.

IV. Unclassified aims—4.
- It is so important that it should have a place—1.
- The work is interesting—1.
- It discovers whether student leans to science or not—1.
- Keeps people in school—1.

The dominant aims, then, of general science are to prepare for the specialized courses, and to explain environment, utilitarian, both of them. Many instructors made much of the third aim, one reporting that it convinced the school board in his city.

The answer received to the question, "What are the advantages of a course in general science?" show that advantages are along the same lines as the aims and purposes. One instructor replied, "The advantages are too numerous to mention." While another enthusiastically declared, that there was not room on the paper to put them all down. Still another reports that general science is such a good foundation for later courses that there may have to be two sections in the later courses, one for the students who have had general science and another for those who have not had it. The advantages are classified below:

I. It is a foundation for later courses—29.
- Stimulates an interest in science—12.
- Gives general knowledge in science—1.
- Prepares people to choose science later—8.
- Correlates science—2.
- Introduces scientific methods—2.
- Make ground work for other science—1.
- Introduces a scientific attitude of mind—1.
- It makes a quick get-a-way in physics and chemistry—1.
- It gives more advancement in higher courses—1.
- It dispels the haze that attends the beginning of advanced courses—1.

II. It explains environment—10.
- It explains everyday life—9.
- Students who take it get an appreciation of nature—1.

III. Unclassified advantages—9.
- It covers all the sciences at any time—1.
- It has big teaching values—social, intellectual, etc.—1.

Most people have an interest in science at that age—1.
It humanizes the curriculum—1.
It teaches how to study—2.
The course is popular—1.
It keeps people in school—2.

The fact stands out, that the great advantage of general science for the student is that it makes future science easy to him. But we cannot judge from the figures that he is prepared for future science twice as much as his environment is explained to him, for explanation of environment and preparation for future courses undoubtedly go hand in hand in most instances.

Any course which is new in a curriculum naturally has some disadvantages. Below are the limitations of general science.

I. Content—28.
Scattered information—no sequence—1.
Cannot be thorough in any one subject—11.
Too general for specific knowledge—5.
May lead pupils to think that future courses are as easy—1.
May be so hard as to kill interest in future courses—1.
May be bookish—1.
May go beyond the pupils experience—1.
Will be repetition of topics for those who go on—1.
May take away interest for science later on—2.
May be made too difficult—1.
There is little of intrinsic worth in the course—1.
Hard to select topics on which to lay emphasis—1.
Supersedes physiology—1.

II. Lack of facilities—11.
Poor texts—1.
Lack of laboratory facilities—9.
Lack of properly prepared teachers—1.

III. Administrative—5.
Curriculum too crowded—1.
People too young—1.
Student neglect other work to read up on science—2.
Sections too large—1.

The dissatisfaction expressed under the heading "Content" is well summarized by one teacher: "Too many bites and not enough chewing." That depends on our aim—Are we trying to teach the

pupil some of each phase of science or are we giving to the pupil an understanding adequate to his needs, of such phases of science as affect his everyday life? Lack of facilities in many schools might as well refer to the other sciences also. But the disadvantages under the last two heads will disappear when general science is firmly established and the content of general science will be adjusted as specific aims are followed.

A state of affairs which is not only true for other subjects as well as for general science, particularly in small schools, is brought to light by the answer to the question, "What other subjects are taught by the general science instructor?" We find that of the 65 general science teachers who replied

2 general science teachers teach no other subject.
15 teach one other subject.
24 teach two other subjects.
13 teach three other subjects.
11 teach four other subjects.

The following table shows what subjects besides general science, 65 teachers handle.

No other subjects—2.
Mathematics—1.
Mathematics and Athletics—1.
Commercial—2.
Other sciences—29.

Other sciences plus one of the following:

Mathematics—9.
Athletics—1.
Commercial—2.
Latin—2.
Public Speaking—1.
English—2.
Literature—2.
Economics—1.
History—1.

Some of the bizarre combinations are due, no doubt, to the limitations of the school program; but many of them seem hard to justify on any grounds. Efficiency in the teaching of science, general or special, or any other subject will be increased as such combinations disappear.

Although general science courses are general in name, sometimes

certain phases predominate. One school reversing the procedure reports that their general science course is scheduled as agriculture. The replies obtained from the question "Does the course refer chiefly to physical, biological or physiographical topics" are shown below:

Phase Predominating	*In high school*	*Below high school*
No particular phase	30 times	4 times
Physiography	9 "	
Physics	8 "	1 "
Physical Geography		1 "
Agriculture	1 "	
Physiography and Physics	8 "	
Physiography and Agriculture	1 "	
Physiography and Biology	4 "	
Physics and Physiology	1 "	
Physics, Physiology and Chemistry	1 "	1 "

Another compilation of the above data shows:

Phase Predominating	*Times mentioned*
Physics	24
Physiography	22
Biology	6
Chemistry	4
Agriculture	2
Physiology	1
Physical Geography	1

One of the administrative problems that must be met when a new subject is introduced in the curriculum is "Shall the course supersede another, or shall it be a distinct addition?" The following table shows how seventy schools answered the question, "What subject, or subjects, did general science supersede?".

Superseded Subject	*In high school*	*Below high school*
Nothing superseded	19 times	8 times
Physiography	28 "	2 "
Physical Geography	5 "	
Geography		1 "
Botany	2 "	
Biology	1 "	
Agriculture	1 "	
Physiography and Botany	2 "	
Biology and Physiology	1 "	

Considering the subjects separately, we find the following:

Subject superseded	*Times mentioned*
Physiography	33
Physical Geography	5
Geography	1
Botany	5
Biology	1
Agriculture	1

We find that, in most cases, sciences that are superseded are not lost entirely in the curriculum as is shown in the following table in which only ninth grade subjects are considered.

Subject	*Times emphasized*	*Times superseded*
Physiography	22	33
Biology	4	1
Agriculture	2	1
Physiology	2	1
Physical Geography	1	5
Geography		1
Botany		5

Seventy-four instructors report the following text:

Snyder—First Year of Science—24.
Hessler—First Year Science—13.
Caldwell and Eikenberry—General Science—13.
Clark—Introduction to Science—11.
Pease—A First Year Course in Science—9.
Weckel and Thalman—A Year in Science—1.
Mayne and Hatch—Agriculture—1.
No text used—2.

The wide difference of general science text book writers on the content of the general science course is shown in the following table, which is a revision of Table I "Number of pages in General Science Texts given to the different special sciences", as given in "General Science in Iowa High Schools" by E. E. Lewis, School Review, June, 1916.

	Hessler	*Clark*	*Snyder*	*Caldwell*	*Pease*	*Weckel and Thalman*
Physics	150	249	67	76	74	51
Chemistry	88	56	10	12	22	59

	Hessler	*Clark*	*Snyder*	*Caldwell*	*Pease*	*Weckel*
Biology (Zoology, Botany, Physiology)	178	26	82	131	48	230
Agriculture	10	0	15	15	2	7
Geology	14	0	198	19	83	20
Meteorology	26	0	41	39	12	29
Astronomy	0	0	30	3	31	0
Commercial Geography	0	0	0	8	0	0

Mr. Lewis reports difficulty in distributing material appearing in the texts and that therefore the above table does not accurately show the portions of the book spent on each specialized science. It is, however, sufficient for a rough comparison. We find that, considering all the texts together, they emphasized the phases of science in the order in which they are emphasized in the general science courses in the state, Physiography first, Physics second, etc.

Due to an unfortunate oversight while the questionnaire was prepared, no data are available to show what percentage of the whole number of pupils in the grade elect general science; we can, however, discover how interested the pupils are who do elect the course. In the answer to the question, "How do pupils show an interest outside the class room?", we find the following manifestations of interest and the number of times mentioned.

Perform experiments at home and after school—23.
Request information and explanation—5.
Cite observations of phenomena—12.
Interest in apparatus (wireless, engines, dynamos, manufacturing plants)—6.
Bring specimens to school for identification (and apparatus)—9.
Conversation outside of school—6.
Bring clippings from papers—5.
Outside reading (including systematic reading of scientific magazines)—7.
Asking questions—13.
Pride in note books—1.
Applying principles to phenomena—10.
Suggesting problems and explanations—3.
Formation of science club—1.
Use science subjects in English composition—1.
Students now question what they once took for granted—1.

One instructor declares, that, "there is not enough room on the paper to mention them all."

The above list also shows that the student is really interested in class as well as out of it. From their point of view, they are consciously getting an explanation of their environment. What better reasons for being interested are there than the fact that the principles studied explain things and intimate experiences—building fires, removing stains, keeping afloat in water, how a dynamo runs, etc. Anyone who has taught general science has experienced the joy of seeing pupils really enthusiastic and such enthusiasm, properly guided, can be made to realize any aim that can be formulated.

The following table is compiled from data received in answer to the question, "in what phase are the boys most interested? the girls?". The numbers given refer to the frequency with which the phases were mentioned.

Phase	*Boys*	*Girls*
Machines	1	
Physics	9	4
Chemistry	7	3
Manual Training	1	
Mechanics	1	
Electricity	6	
Practical	2	
Practical Experiments	4	
Showy Experiments		1
Astronomy	1	1
Botany		7
Zoology		2
Physical Geography		2
Domestic Science		10

These figures are not to be interpreted thus; The boys are interested in machines in only one school; rather in this fashion—in one school boys are predominantly interested in machines, being interested in other things also. Similarly for other figures. The table show that the interest of the boys are along the lines that deal with the world in which they are living—the world of industry. The girls, as is somewhat to be expected, are interested in the practical affairs of the home; they also find interest in Botany, Zoology and Physical Geography—subjects which do not appeal to boys so much probably because the practical side of these sciences are not so apparent.

Answers to the question, "Is the course elective or compulsory?" show the following data.

In the high school, ¾ of the courses are elective and ¼ compulsory.

Below the high school, 1-3 of the courses are elective and 2-3 compulsory.

The majority of courses in the high school are elective; the majority below the high school are compulsory.

The following table shows what percentage of students who elect general science are boys and girls.

Per cent. of Boys	*Per cent. of Girls*	*Times reported*
40	60	7
45	55	4
50	50	9
55	45	4
60	40	11
70	30	4
80	20	5
90	10	2

We find that, on the average, the large percentage of students are boys. If we average the percentages and consider all the individual elective courses combined into a large class, we find

Boys	61.4%
Girls	38.6%

The size of sections in general science do not vary very much from the size in other courses. Here are the data.

Number in class	*In high school*	*Below high school*
Below 10	1	
10-14 inclusive	2	
15-19 "	11	
20-24 "	15	5
25-30 "	18	12
31-34 "	4	2
35-39 "	2	
40-50 "		1

We notice that the sections are, roughly speaking, larger below the high school than in the high school, and that, considering the high school courses only, 33 out of the 53 schools reporting have classes between 20 and 30. The data available show that no general state-

ment can be made about the relationship between the size of compulsory and elective courses.

The number of class meetings (including laboratory meetings) per week is shown in the following table.

No. meetings	*In High School*	*Below High School*
5	51	11
4	2	
3		2
2		1

Length of the recitation period is shown below.

Length	*In High School*	*Below High School*
45 minutes	52	6
40 "	4	1
60 "	2	1
20 "	1	1

The data received in answer to the question, "Is a laboratory used in connection with the course?" show that the following interpretations was made by the word "laboratory".

I. Demonstrations made by the teacher in laboratory.

II. Individual laboratory work by students as is carried on in the specialized sciences.

At any rate if we consider that the answer "yes" means that there is some other work besides the work in class, either as laboratory demonstrations or individual laboratory work, we find that

90% of high school courses have laboratory work.

40% of courses below the high school have laboratory work.

10% of the replies from the high school courses stated that they had class demonstrations; 37% of courses below the high school have the same, so we may conclude that all the ninth grade courses have either laboratory or class demonstrations; 77% of courses below the ninth grade have the same.

The manner in which the laboratory is conducted is shown below:

	In High School	*Below High School*
Laboratory demonstrations by teacher	40%	75%
Individual work by students	25%	10%
Both	35%	15%

The following table shows the nature of the laboratory outlines used:

Pease Laboratory Manual	7	times
Caldwell, Eikenberry, and Pieper	9	"
Hessler	7	"
Mimeographed directions	2	"
None	51	"

Of these, the directions are found in the back of Hessler's text; the other two are separate volumes. In the case of the 51 who have no printed instructions, the experiments are in some cases suggested by the text, by the laboratory manuals, of the specialized sciences or by experiments from different general science manuals.

Home experiments are performed by students in 80% of the high school courses, and 66 2-3% of the courses below the ninth grade. Note books are kept in 88% of the courses having laboratory in high school and in 66 2-3% of the cases having laboratory below the high school. The following table shows the length of the laboratory period:

Time in minutes	*In High School*	*Below High School*
40	3	
45	31	6
60	3	1
80	1	
90	1	11

Below are some examples of how some schools divide the time per week in high school general science.

High School Enrollment	*Number of Recitations*	*Length of Recitations*	*No. of Laboratories*	*Length of Laboratory*
133, 335, 70,270	4	45 min.	1	90 min.
45	3	40 "	2	80 "
550	3	45 "	2	80 "
400	4	45 "	1	70 "
250	4	30 "	1	60 "

Number of laboratory periods per week.

Number	*In High School*	*Below High School*
1	15	2
2	20	0
3	2	2
0	4	8
varies	12	2

The following table has been prepared to show the time spent per week on general science.

Minutes per week	*In High School*	*Below High School*
90		3
135		2
200	5	
225	40	5
270	6	
300	3	2
315	3	
330	1	

It will be noticed that there are only a few instances of courses that do not meet at least 5 times a week; that in only one case is the length of the period under 40 minutes. As in the high school courses, 51 are 1 year courses and 8 are ½ year courses, it will be seen that the great majority of cases, at least 120 60 minute hours are spent per year in the course, thereby equalling the time spent in the recognized science courses.

General science is conceded by many to be in an experimental stage. Unlike some other subjects in the high school curriculum that are undergoing changes, it has not yet won recognition by the University of Michigan as a unit for entrance, although the faculty have been considering it for some time; as it now stands, the university is waiting for recommendation from the Schoolmasters' Club. With a view of ascertaining the opinion of the science men (the people who would be qualified to state one way or the other, as they are making the course) on the matter, the question, "Do you believe the general science course to be of such a character as to merit recognition as a unit by the university?" was added to the questionnaire.

One hundred thirteen replies were received to the question; of these 73 were from schools having the course, and 39 from schools not having it. The following table shows the results.

	Schools having course	*Schools not having course*
Yes	67	23
No	5	15
Undecided	1	2

We notice, that the ayes have it by a big majority in schools where the course is found; in schools where it is not found, more

than fifty per cent. are in favor of giving the course recognition. Combining the two columns we have

In favor of recognition—90.
Not in favor of recognition—20.
Undecided—3.

These numbers show that 88% of those who answered the question are in favor of giving it recognition. A bigger percentage in favor of recognition is shown in the case of schools having the course. In those schools, where we must consider that the advantages and disadvantages of general science are actually realized, the percentage in favor of recognition is 91%. That only 3 reported that they were undecided, shows that this question has been rather fully contemplated by those answering. There were many answers that read "emphatically yes", and in other ways showed that the instructors had no doubt about the matter.

The reasons given for thinking that the course should be recognized are as follows:

If the teacher is capable.
Ought to have as much recognition as other science.
Students will take it if the University gives credit.
If the course has a laboratory and is not a hodge-podge.
As course is largely physiography, and physiography was recognized, general science should be recognized.
It has a direct bearing on the observation of normal students.
It is as much an observation, thought and reason developer as any other subject.

The following reasons are given as not being favor of recognition.

There is not enough unity of aim.
It is not standardized.

Of those undecided, all agree that action should be taken at once, in fact, there is a general opinion throughout the state that "something ought to be done about it soon". Some schools are in this position—although they consider the course as good as any other, and it is one that they want to recommend to students, yet they hesitate to do so when the students should be taking work for which he will be getting entrance credit at the University. This is particularly true in schools where the curriculum is crowded.

A complete list of universities and colleges that recognize general science as an entrance unit is not available. Practically all of the

western universities allow a unit of entrance credit for it, as do several of the southern institutions. A partial list of universities recognizing it are—Chicago, California, Northwestern, Nebraska, Arkansas, Mississippi, Alabama, Georgia, Kentucky, Ohio, Iowa, Kansas, and Texas. Several of the universities accept it from students who come from strong high schools.

General science is here to stay; and with university recognition,* high school general science will take the place in Michigan schools that it merits.

The Place and Purpose of General Science in Education[1]

W. G. WHITMAN, Normal School, Salem, Massachusetts.

In these days of struggle for world democracy, there is a loud call for science and for men with scientific training, but the value of science applied to the development of nations in peace is by no means less than it is for nations at war.

Leaders in education are asking that pupils be taught science at the right time and in the right way. Educators recognize the need of science training and are lending their aid to promote a natural method of studying science. This natural method is the so-called "project method or the method of the science Masters",[2] which is advocated for general science pupils. This is not antagonistic to the scientific method of studying science, which older pupils can use to a greater extent, but it uses the scientific method to the extent that the capacity of the pupil will permit.

It is becoming apparent to men of affairs that they are hampered by their ignorance of the scientific point of view.[3] The merits of many an industrial proposition can only be gauged by one who has a broad view and an appreciation of science.

"Many an elderly professional man, looking back on his education and examining his own habits of thought and of expression, perceives that his senses were never trained to act with precision;

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* The University of Michigan now gives a unit of entrance credit for general science.—Ed.

[1] Paper given before the Science Section of Tufts College Teachers' Association, Oct. 27, 1917.

[2] Woodhull, p. 249, Vol. II, General Science Quarterly.

[3] Little, p. 9, Vol I, General Science Quarterly.

that his habits of thought permit vagueness, obscurity, and inaccuracy, and that his spoken or written statement lacks that measured, candid, simple quality which the scientific spirit fosters and inculcates."[4]

"The devotees of natural and physical science during the last one hundred and fifty years have not shown themselves inferior to any other class of men in their power to reason and to will, and have shown themselves superior to any other class of men in the value or worth to society, of the product of those powers. The men who have done most for the human race since the nineteenth century began, through the right use of their reason, imagination, and will, are the men of science, the artists, and the skilled craftsmen,—not the metaphysicians, the orators, the historians, or the rulers."[5]

Some university scientists are asking that the high schools do more of the science which is now done in college in order that in college they may specialize to a higher degree than at present.[6] Others are asking that more students be interested in science. There has been in recent years a lamentable falling off in the per cent. of students who study science. This fact has given science educators much concern.

Society demands a wider acquaintance with natural phenomena and devices utilizing natural force.[7] We are now surrounded by such an array of science devices in the home, in the shop, in travel, in fact, everywhere, that he who would get the most out of life must have knowledge of many science facts. He who would not appear ignorant in common conversation must look to his science. Ignorance of the explanation of a common application of science was once considered excusable in a man who knew literature and Latin, but today, it is different. He who would contribute his just share to community welfare must understand some of the science which is the basis of good health and sanitation.

We thus see that educators, men of affairs, professional men, scientists, and society are in agreement that science training is proper and essential to the development of a normal member of society.

To these demands for a training in science may we add that

[4] Eliot, p. 8, Bul., 1916, No. 10, Bureau of Education.
[5] Eliot, p. 12, Bul., 1910, No. 10, Bureau of Education.
[6] Dr. Charles S. Palmer, Mellon Institute.
[7] General Science Manual, Mass. Board of Education. Bul. 81, Page 12.

there is a natural desire for science knowledge on the part of boys and girls who have not met discouragement in their endeavor to learn by the natural or project method.

With all the serious demands made upon our pupils, are we not under obligation to exert our best efforts to lead them to develop into useful members of society? Is it not true that science is a necessary agent in promoting this development? Who will say that science is not essential to an appreciation of our world and of the things which maintain our high degree of civilization? Science is the step-stone of progress; we must give her our best.

Society needs some highly trained specialists as those in the various departments of science, professions and industries and she needs the masses of people who have a more limited but general knowledge and appreciation of science. The science specialist must have long training in the highly specialized details of science. This will usually be obtained in colleges and universities by building upon the science foundation laid in the high school. The more limited general science training of the masses of people will be obtained as a rule before completing the high school course. Both these groups will continue to add to their knowledge long after they have finished their school training. The school training serves largely to fix habits to be followed in later life.

It is important to recognize these two groups and not to impose the exacting requirements of the one upon the other. "Since science has come to be the dominant note in modern life, science itself has the largest part which it has ever held in the history of education. It will use that opportunity or not, determined by whether it faces frankly the problem of using the science of common affairs with which the masses of people deal rather than making the futile attempt of imposing upon people the special aspects of science which are properly of interest to special students."[8]

The science which will meet the needs of the masses in fulfillment of their obligations to society must, of necessity, be drawn from wide fields. There is no special science which may not make some contribution. Because of the broad, general field which this science must embrace, the name *general science* is appropriate and is the name by which such a course is commonly known, though in some localities the names *elementary science* and *introduction to science* are used.

[8] Caldwell, page 135, Vol. I, General Science Quarterly.

Let us now consider briefly the purpose and method of general science. I would state the aim as follows:—to develop in the pupil such an attitude toward nature and toward the products of man's work in utilizing the various materials and forces of nature that there will arise in the pupil a self-impelled desire to carry on studies or investigations about these things in his environment. Let us encourage the pupil to "want to know" about the various science devices in the home, in transportation, in travel, in industry, and about natural phenomena. When a pupil has become so interested in a subject that the incentive to continue the study is so strong that sustained self-activity results, then the pupil has a *project*.

The project is something which a person "throws forward", plans or devises. A science project involves the self-activity of a person in the solution of some problem, in finding the answer to some question, in the construction of some device or the preparation of some material. It involves a desire on the part of the person to carry on the investigation or to make the thing projected. Thus a project is always a self-imposed task. This may be an investigation carried on by an individual member of the class—the individual project—and a report made to the class, or the entire class as a group may become active upon a certain matter, thus making a class project. In a class project it is possible to have different members make individual studies by reading, by questioning, by experimenting, by construction or by other means and bring their reports together in class discussion.

The project method develops originality, initiative, activity, power—all desirable qualities. A project cannot be imposed upon a pupil by the teacher. The teacher can suggest topics or subjects and these may or may not develop into projects. The teacher should strive by encouragement, by all the arts and devices within his power to develop in his pupils that scientific attitude of mind which is alert, which questions, which observes, which reflects, which reasons, which decides,—that attitude of mind which takes a topic or a problem and makes it a real project for intense personal study. This is the kind of school training which gives the pupil real education. This is training the pupil to attack problems in the practical way in which it is done in real life by real scientists. Thus it is that the project method is called the "method of the science masters".

In practice most of us get relatively few of our students to work

upon real projects. Is our effort of no avail when we fail to start projects? By no means. There is unquestioned value in the knowledge of many science facts; there is satisfaction in understanding the explanations of certain phenomena of nature; there is value in acquiring a scientific attitude of mind. The pupil secures much valuable training, knowledge and appreciation whether or not the study reaches the stage where it can rightly be called project study.

But the goal for pupil and teacher is the project study, for then interest becomes fascination and work, which at other times is drudgery, becomes pastime. Those things of value which are the products of a study of topics, are obtained as by-products in project study.

Under the usual school conditions, I do not yet see any way of giving up the study of topics, and substituting in its place a study of projects. The most successful teacher is the one who understands his pupils, their environment, and the vital contacts which pupils make with the science applications in their environment. If he has boundless enthusiasm and inspires his pupils with a love for science, projects will spontaneously arise in the pupils' activities.

Projects are characterized by Prof. Mann. as follows:

"(1) A desire to understand the meaning and use of some fact, phenomenon, or experience. This leads to questions and problems. (2) A conviction that it is worth while and possible to secure an understanding of the thing in question. This causes one to work with an impelling interest. (3) The gathering from experience, books and experiments of the needed information, and the application of this information to answer the question in hand."

The chief aim in general science is not to cover a prescribed list of topics, not to acquire a certain body of science knowledge, but rather to secure a certain attitude of mind toward science, and thereby to develop a scientific spirit. Much valuable knowledge will be gained as a by-product.

In the development of a project a pupil is limited only by his capacity, his available material and his time. It may lead him into any field of science. The natural science project recognizes no artificial special divisions of science. The special sciences of the high school ought not to impose any requirement upon the general science, but rather to build their own courses upon the foundation presented to them.

"Children and adults alike are endowed by nature with the elements of the scientific spirit. The purpose of science teaching is accomplished most successfully when the science classes merely furnish and shape an environment in which the scientific spirit may grow."[9]

Where in our scheme of education can this general science be most effectively taught? Before making a definite answer to this question let us consider the science opportunities of our pupils in the average school at the present time. In the earlier grades, science takes the form of nature study. In some schools, nature study is continued through the eighth and ninth grades. In other schools, no science or nature study is given in the seventh and eighth, or the seventh, eighth and ninth grades. This is largely because of the lack of interest in nature study and the fact that no teachers are available to teach science. In a few schools, elementary special science as elementary physics or elementary botany is taught in these grades, but these subjects have not been very satisfactory. Beginning in the ninth grade or the first year of the high school, special science has been tried, but in the majority of cases it has been abandoned as a failure. Within a comparatively few years, general science has been tried in the first year of the high school with marked success, and the increase in schools adopting this course in phenomenal. In the last three years of the high school, and in four years of some schools, special sciences, as chemistry, biology, physics, geology, and astronomy are taught. These subjects are organized from the standpoint of the mature scientist, and in many instances, represent work too highly specialized for the immature pupil, but for pupils who have had a grounding in the science of common things, these courses are reasonably satisfactory.

As we consider the science training now given the pupils from kindergarten through the high school, it appears that those pupils in the seventh and eighth grades are most poorly cared for. The nature study subject matter and method are fairly satisfactory through the first five or six grades, but in the seventh grade, the pupils are capable of more serious work. They are not ready, however, to plunge into an adult special science. To pupils in the seventh, eighth, and ninth grades, continuation of the usual nature study is

[9] Woodhull, p. 250, Vol II, General Science Quarterly.

like continuing baby talk after one can use real words, while undertaking a special science has the danger of leading to a vocabulary of meaningless words in a narrow field.

As the problem appears to me, we need a course, or a series of courses, which shall bridge this gap in science from nature study of the sixth grade to the special science of the last three years of the high school. This should be broad in its scope, without bounds as to special fields, and cover a period of three years. In the first of these three years, in the seventh grade, the course might well take more of the form of nature study, making a gradual transition from nature study to general science. In the ninth grade, or the first year of high school, it may look forward, somewhat, towards special sciences, again making the transition gradual for those who will continue science.

General science in the elementary school needs expert handling. It is perhaps the most important epoch in the pupils' science training. The beginning of science is of more importance than the ending, "for", says Dr. Dewey, "no amount of pains and ability in the high school can make up for a wrong start or even a failure to get a right start (in science) in the grades".[10] It is therefore highly important that high school science men should interest themselves in the general science problems of the elementary school.

A very large number of our pupils will never get any science in school after the ninth grade and it is highly important to give them the general, useful, interesting science which will make them better citizens. This general science, if given for three years, may well include the physiology and hygiene. Good health and right living are subjects so closely related to many science topics that they may well be carried on together in one course. Many civic questions in the community civics course closely touch the science topics and these two may be worked in correlation. The manual training teacher, if he will co-operate with the science teacher, can work out many of the construction projects with pupils in the shops; as, for example, making motors, telegraph instruments, etc.

Three years of general science is already a fact in quite a large number of schools. Massachusetts is not taking the lead in this movement, however. Superintendents say they believe in it and would like to have it, but they have no teachers who can handle

[10] Page 4, Vol. I, General Science Quarterly.

it. When they feel the need of it so strongly that they will insist that the teachers they hire—normal school graduates—shall be able to teach general science, then the normal schools will prepare general science teachers. Until that demand is made imperative, the normal schools will continue to fit teachers for those subjects which are now in strongest demand. The argument that teachers cannot be supplied for general science work is invalid. If superintendents make the demand strong, a supply will follow. Boston, Rochester, and some other cities are meeting the need by having the science teacher in the system best fitted for the work, train other regular teachers for the work at Saturday classes.

The establishment of the junior high school has given impetus to the three year plan of general science. If the school includes the seventh, eighth, and ninth grades in one system of organization, it makes it easier to handle the general science from the administration side. A science supervisor or director can have charge of the work of the three grades. It is in the junior high schools that the greatest progress has been made in extending general science over a period greater than one year.

We hear some fear expressed about "duplicating this science work in the special sciences later in the high school", that general science is stealing from those courses "the interesting and spectacular feature," thus leaving nothing by which interest in that science can be stimulated. This fear is unnecessary.

In the first place, the majority of pupils who take the general science will not take all the special science later, and there is little danger of any harmful repetition for those who do. If the same subject comes up in the future, the pupil is able to go further in it than before. In general science it is not advisable to attempt to exhaust any subject. Let the pupils go only so far as they can efficiently. There is a limit to their capacities and so a point beyond which it would be unwise to carry them. By following this plan, the pupil never thinks he knows all about a subject. He therefore remains alert to gather more about a subject in the future.

In the second place, a certain amount of duplication is beneficial. It is only by repetition of certain acts that we acquire manual skill. So it is with mental actions. Many important science principles can be understood in no satisfactory fashion without their being repeatedly reviewed and examined from many different view points, so I would call this cry of "danger of duplication" a false alarm.

If the use in general science of a few striking demonstrations from any special science field leaves that science so poverty stricken that it cannot interest the pupils in it, then it is just as well that the pupils do not take it. General science, however, does not depend upon spectacular demonstrations to hold the pupils interest.

The demand for this general science training is gradually becoming more insistent as its value is appreciated.

"The best part of all human knowledge has come by exact and studied observation made through the senses of sight, hearing, taste, smell and touch."[11]

"The elementary school needs to set a definite standard of attainment, not lower or easier but higher and harder, a standard in which the training of the senses shall be an important element."[12]

"Science should be taught in the most concrete way possible—that is, in laboratories, with ample experimenting done by the individual pupil with his own eyes and hands and in the field through the pupil's own observation guided by expert leaders."[12]

Is this general science of interest to colleges? Yes, because the breadth of view gained will be of more value to any pupil who will later undertake a course in special science. Colleges ought to give a unit of credit for a year of high school general science. A number of colleges already do give this credit. The University of Michigan, after considering the question two years, last June voted to give ½ or 1 unit of credit for general science depending upon whether the pupil's course was ½ or 1 year in length. It is to be hoped, however, that colleges will not try to make over the general science course by preparing syllabuses. General science is a high school product and it is best that it remain free from college denomination. It is a course primarily intended for pupils who will not go to college, and yet it is perhaps of equal value to those who do go.

Let me close with a quotation from Dr. Snedden, Former Commissioner of Education for Massachusetts. "In a somewhat general way we are purposing that, by means of education in general science, we shall inspire and assist these youths that they may, in an appropriate degree, take satisfaction in comprehending in other scientific aspects those manifestations of nature, on the one hand, and those works of man, on the other, by which they are environed.

[11] Eliot, Bulletin 1916, No. 10, Bureau of Education.
[12] Eliot, Bulletin 1916, No. 10, Bureau of Education.

Because of this comprehension we have faith that they will lead better and fuller lives themselves, and will be more companionable and useful members of the larger society in which they are to live as adults. Then, too, we expect that each one will, in a measure, derive from these studies some form of specific knowledge, power, and interest that will guide and reinforce him when he comes to do his share in the world's needed work."[13]

The Story of My Suit:—An Outlined Project

W. W. D. SONES, Schenley High School, Pittsburgh, Penna.

The following outline is intended to be merely suggestive. It serves as a matrix about which a great deal of valuable discussion may be associated. The organization should be in the teachers mind alone, since the elements that are contained therein can readily be developed out of the pupils own experience. Perhaps the class will choose to begin at what has been placed at the end. This should be permitted. However is it usually possible to lead a class in the desired direction by the proper type of questions. Brevity demanded that a bare outline be presented, but, in use a definite teaching plan with questions should be prepared. The exercise may consume a week or a month as desired.

THE STORY OF MY SUIT.

Introduction—What is the purpose of animal coverings?

1. *Protection* as shown in long haired coverings? Feathers in the case of birds, etc. Covering of tropical animals. Covering of "cold blooded" animals.
2. *Sex selection* as illustrated by sex differences in coverings in birds, mammals, etc.

I. Why is clothing worn?

A. Protection.

1. From changes in temperature.
   a. How clothing produces "warmth".
   b. Heat conductivity of materials used.
   c. Value of air space—illustrate by building construction, etc.

[13] Snedden, Problems of Secondary Education, Copyright 1917. Published by The Houghton Mifflin Co.

d. Effect of color on "warmth"—summer versus winter colorings.
e. Loose versus tight weaves.
f. Hygiene of clothing.

2. From wind.
a. Why wind chills. Hygiene.
b. Tightly woven materials for outer garments.

3. From water.
a. Water-proofing materials.
b. Construction of my rain coat.

B. Adornment.
1. Develop the idea of the use of clothing as a determiner of social status. Ill effects of such procedure. Practice of religious sects such as Friends.
2. Clothing for sex attraction. Compare with lower animals. Does "Clothing make the man"?

II. What materials are used in clothing.
A. Animal fibres.
1. Wool.
a. Origin of wool.
b. Preparation for spinning.
c. Characteristic of wool fibre.
d. Spinning the yarn—past and present.

2. Silk.
a. Origin of silk.
b. Preparation for spinning.
c. Special characteristics of silk fibre.
d. Spinning the thread.

3. Fur used for clothing.

B. Vegetable fibres.
1. Cotton.
a. Origin of cotton.
b. The cotton industry in the U. S.
c. The story of Eli Whitney.
d. Characteristics of the cotton fibre.
e. Spinning the thread.

2. Flax.
a. The flax plant.
b. Treatment of flax.

c. Characteristic of fibre.
d. Spinning of linen thread.

3. Other plant fibres.

III. How is cloth woven?

1. Straw weaving of primitive peoples.
2. Principles of weaving—woof and warp.
3. The hand loom.
4. The power loom.
5. Some common weaves—serges, twills, etc.
6. Weaving as a vocation.

IV. How are the colorings secured in cloth?

A. Bleaching.

1. Natural color of the various textile fibres.
2. Home bleaching agents; methods in Colonial times.
3. Chemical bleaching.
   a. Treatment of animal fibres.
   b. Treatment of vegetable fibres.
   c. Effect of chemical agents on durability.

B. Dyeing.

1. Dyeing as practised in the Colonial home.
2. Vegetable dyes; present state of industry.
3. Coal-tar dyes; effect of the war; reason.
4. Commercial dyeing. a. Direct. b. Indirect.

V. How was my suit made?

1. Compare present factory methods with custom tailoring. Interdependence of the various workers who helped to make "my" suit. Tailoring as a vocation. Evolution of clothing.
2. Develop origin of style. Show effects of past customs on present style. What is "fashion". Fashion versus economy.

Laboratory or home exercises.

1. Tests for textile fibres.
   a. Alkali test.* b. Odor test. c. Absorbtion of water.
2. Microscopic examination of fibres.
3. Effect of soap with free alkali on woolens.

* This can be motivated by having pupils write to mail-order concerns for samples and check up on catalogue descriptions.

4. Bleaching.
5. Dyeing—direct and indirect.
6. Preparation of vegetable dyes.

Concrete Aids.

The entire exercise permits of instruction in the concrete. Furthermore the materials lay close at hand. Included are:

1. Examinations of the textile fibres in process.
2. The various weaves.
3. Components of soap.
4. Visitations; including custom tailor, dyeing establishment, textile plants, museum for early styles of dress.
5. Bleaching and dyeing agents, etc.

Readings.

Dooley— Textiles. Heath.

Nystrom— Textiles. Appleton.

Tryon— Household Manufactures in the United States. University of Chicago Press.

From Wool to Cloth. American Woolen Co., Boston.

How we make Thread. American Thread Co., Willimantic, Conn.

Hooper— The Loom and Spindle. Smithsonian Inst.

Silk: Origin, Culture, Manufacture. Corticelli Mills, Florence, Mass.

Current general science texts for readings on dyeing and bleaching.

An Applied Science Shop in a Junior School

George R. Miller, Trenton, N. J.

It is slightly more than a year since the opening of the Junior School of Trenton, N. J. It has, among other features of merit, a shop which is perhaps unique in school work.

This shop is forty by sixty feet. Its light comes from windows east, west and overhead. It is equipped with fifteen wood-wording benches, fifteen vises, a pipe vise, forge, two anvils, drill press, gas stoves, soldering irons, emery grinder, and two high-speed lathes. There is also a well equipped tool room to enable the pupils to carry out a wide range of operations in metals.

This shop was established for a variety of purposes, the chief one being the correlation of manual training and the sciences; other purposes were to establish a relation between the school and the home, to foster any initiative or originality that might be apparent in a pupil, and to meet, as far as possible, any demands arising from associations of the boys themselves.

The first of these purposes is met by the construction of physical or other apparatus, some of which is demanded by the school, and others designed by the instructor.

A relation between the school and the home is effected by allowing the pupil to sharpen cutlery, repair agate and tin ware, and to make such minor repairs as may be demanded in any household.

Initiative and originality are encouraged by permitting pupils to carry out ideas that they may have, thus, one believes that he could build a holder for solder that would effect a saving in time and material.

Neighborhood, school, and church associations bring about demands for small things which this shop tries to satisfy.

What follows is a partial list of the things done since our opening: a meter measure, litre can, half pint cup, balance, lever, pulleys, derrick, force, suction and compression pumps, tops, kites, water-level and water-pressure apparatus, pneumatic troughs, metal book-brace, scheme to show ventilation, permanent magnets, sounder, electric motor, electric heater, contact key, and wireless apparatus. Tools for metal and wood are made and repaired, bicy-

cles and "Boy Scout" outfits are kept in order, knives, scissors and hatchets are sharpened, and badges for school and other associations are prepared.

Some of the original schemes had to be abandoned because they were not simple enough; the metre and litre measures and the balance belong to this group. Others such as kites and tops, had to be deferred until the season arrived for their use.

If a pupil has a scheme in his mind, an attempt is made to time it with its place in general science; failing in that, the pupil is accommodated at once so that he may not lose interest in the scheme. This loss of interest is very common; it is sometimes due to the length of time required to bring a scheme to its conclusion, but more frequently due to repeated failures to accomplish the end sought. When loss of interest is apparent the pupil is furnished with a simple piece of work, upon the completion of which he is sure to be ready to take up the work in which he lost interest.

The instructor necessarily decides upon *what* shall be done, but not *how* it shall be done unless the pupil shows that he has no ideas about the work.

The pupils are expected to construct from the raw materials to the finished product in order that they may obtain a wide knowledge of the properties of matter.

Material of Recent Issue Available for General Science

W. W. D. SONES, Schenley High School, Pittsburgh.

There have recently become available for reference work in general science, a number of publications of more than ordinary value. They are to be commended for the saving quality of freshness, which is highly to be desired when we are about the selection of readings for our pupils. Furthermore in material of this nature nothing is presupposed. Everything necessary to the understanding of the topic under discussion, is included, and for this reason, of particular value in project teaching.

1. Lessons in Community and Natural Life. U. S. Bureau of Ed. Sections A. B. C.

   A persual of these leaflets impresses one of the magnitude of

the war and its many ramifications, for they are no less than an attempt to impress upon the school children of America the need for co-operation and conservation. The lessons are of three grades—"Section A for upper classes of the high school, Section B for upper elementary grades and first class in high school, and Section C for intermediate grades. Some of the titles included are: Effect of War on Commerce in Nitrate; Feeding a City; The Aeroplane; A City Water Supply; etc. Price five cents per Section. They can be obtained from Food Administration, Washington.

2. Teacher's Monthly Outline. Popular Science Monthly, New York. Free to Science teachers.

   This outline is designed to assist science teachers who make use of this magazine in their classes. It is to be issued monthly and will be mailed in advance of the publication date of the magazine. This venture promises to serve a real need. The schoolman's point of view is maintained since it is edited by a New York City teacher, Mr. Brownlee.

3. Dixon—Talks on Hygiene. Penna. Dept. of Health. Free.

   Some exceedingly valuable brief paragraphs on personal, home, and community hygiene.

4. Crissey—The Story of Foods. Rand-McNally, Chicago. $1.25.

   Puts in available form some material that has heretofore been inaccessible. It is, as well, easily read by ninth grade pupils.

5. Fisher and Fisk—How to Live. Funk and Wagnals. $1.10.

   This book presents the most recent knowledge about hygiene devoid of pedantry and sentiment. It might well replace most current school texts in this field.

6. The Dawn of the Electrical Era in Railroading. Chicago, Milwaukee, and St. Paul R. R. Chicago. Free.

7. National X-Ray Reflector Co., 235 Jackson Blvd., Chicago. Free.

   How to know and have good lighting.
   Correct lighting for schools.
   How better lighting yields more profits.

Editorials

This has been a year of hardship to periodical publishers. Many have ceased publications until a time when normal prices may again prevail. The expenses of the QUARTERLY for the first year were thirty per cent. greater than estimated. This was in part due to unforseen expenses but largely to increased cost of material and work.

Considering the inauspicious time, from a business point of view, for starting a new venture, the years business has been extremely gratifying. The teachers and advertisers have responded well and the outlook for this year is very promising and we wish to express our deep appreciation to the many who have had the needs of the QUARTERLY in mind, and have contributed to its pages and have obtained new subscribers. Those teachers who wish to show an interest in the continued welfare of the QUARTERLY can help in a very substantial way by increasing the subscription list.

The increase of the subscription prices of magazines has been quite general this year, but it has seemed best for the QUARTERLY to keep its original subscription price and to economize by omitting the frontispiece for a time. Just as soon as financial conditions warrant, the frontispiece will be restored and more cuts used in the text or the number of pages increased. Perhaps all three can be done. It depends upon your own interest and help.

The members of the Advisory Board have helped in many ways. Their counsel has been of great value. Because of their very substantial support the QUARTERLY is not carrying a burden of debt. Any reader whether on the Advisory Board or not is invited to send suggestions, criticisms, and articles for publication at any time. Democracy in a professional science journal is as essential as in a government. We desire this journal to have something worth while to the general science teacher and to the special science teacher.

Let us hear from you.

GENERAL SCIENCE VS. ELEMENTARY SCIENCE.

Is it not possible to reach some agreement in regard to the two terms *general science* and *elementary science?* The distinction made by the teachers in Michigan seems to us admirable and we recommend their point of view for your consideration.

In some schools in grades seven to nine, the science courses are elementary physics, elementary botany, elementary chemistry, or elementary physics and chemistry. Each course separates the science material into the special sciences. Such courses are properly called *elementary science.* Courses in elementary science are taught in New York and in Gary, Indiana.

In some schools in grades seven to nine, the science courses comprise units of study, the development of which is not limited to any special science, but the running over into the various special sciences, which can offer any useful knowledge, is encouraged. Sometimes one of these units will not involve science material outside one or two special sciences, but the selection of units is not limited to one field. The courses aim at a more general and broad view of the field of science. Such courses are properly termed *general science.* General science is taught in a large number of schools, from Boston to San Francisco.

The term "elementary science" from association with courses which are chiefly special science courses, is suggestive of such courses. It does not suggest at all the use of material from a broad general science field. The term "general science" does suggest the broad field of science and it must be self-evident to any thinking person that it must be elementary and not advanced science. It seems hardly necessary, therefore, to call it *elementary* general science. By common usage, the term "general science" is sufficient to designate an elementary course which is general in its scope.

With the recent growth of general science has come the *project method.* Progressive general science teachers are trying to the best of their ability, to use the project method to some extent in their work. The project method does not fit into the elementary science idea as well as it does into the general science plan, because the solution of a natural problem or evolution of a project may take one far beyond the bounds of any one special science.

CREDIT FOR HIGH SCHOOL GENERAL SCIENCE IN HIGHER INSTITUTIONS.

For some two years the faculty of the College of Literature, Science and Arts of the University of Michigan have had under consideration the acceptance of general science for admission. The matter was brought to a head last spring by the recommendation made by the Michigan Schoolmasters' Club.

The following recommendation passed by the Biological Conference was concurred in by the Michigan Schoolmasters' Club, March 28, 1917:

It is the opinion of the Biological Conference of the Michigan Schoolmasters' Club that general science is worthy of university recognition, because:

1. The subject is adapted to pupils entering high school.

2. It awakens interest in science in a way that the specialized sciences cannot do with young pupils, for it is organized about the common phenomena of daily life.

3. It has the value of preparing pupils for the later sciences in the high school course, and in preparation for life of those pupils who leave school before graduation.

4. It does not make science easy (snap course) rather than thorough; it can be safeguarded, as are other courses, before recognition is granted. Following are the ways in which it may be safeguarded: (a) student, to get credit for general science, should take it before any specialized science course (botany, zoology, biology, physics, chemistry, physiography, hygiene, or physiology); (b) textbooks on general science should contain enough material for one year's work; (c) laboratory work, on the average of two periods a week, should be required; such work may be demonstrations, individual work by students, or field trips. Laboratory records should be kept. There are several very good general science laboratory manuals at present; (d) the general science instructor should be teaching at least one of the specialized sciences in addition to general science, or have had one college course of the physical or biological sciences.

5. General science, in the majority of Michigan high schools, is safeguarded as above.

6. The majority of general science instructors in Michigan believe that it merits recognition.

Therefore, the conference recommends that one unit of entrance credits be given for high school general science to students who come from accredited schools, provided:

1. That the course is a full year's course.

2. That one hundred twenty full, sixty-minute periods are spent on the course, each laboratory period to count as one period of recitation.

3. That laboratory work (consisting of demonstrations, indi-

vidual work, or field trips) on the average of twice a week, is done in connection with the recitation.

4. That for laboratory work there is available equipment used in the specialized sciences, together with what may be needed for general science.

5. That the general science instructor shall, in addition, teach at least one of the specialized sciences, or shall have had one course of college physical or biological science.

It is also recommended that, where the course is half a year in length, it be accepted as one-half unit, if accompanied by one-half unit in physiology, hygiene, botany, zoology, physiography or physiology.

In June, 1917, the faculty of the University of Michigan authorized general science as a half or a whole unit for optional entrance credit.

The following is a statement about credit for general or introductory science made in an announcement of the University of Michigan:

INTRODUCTORY SCIENCE.—One-half or one unit. Instruction in Introductory Science should precede all other courses in science and should preferably be given in the ninth grade.

The aim of this course should be to enable the student to interpret his environment and his relation to it. Teachers of Introductory Science are expected to give instruction also in one of the other sciences and to have had adequate preparation in one physical and one biological science. The ground to be covered by the course should be largely determined by local conditions.

A committee of representatives from the Education and the Science men of the University of Michigan has been appointed to draw up a statement of the preparation advised for teachers of general science.

The vigorous general science movement in California has received a new stimulus in the decision of the State Board of Education to the effect that after August, 1918, all candidates for entrance to the normal schools must have had a course in general science in the preparatory school.

The State Board of Education in Massachusetts for three years has offered examinations in general science for admission to the

normal schools. It is, however, optional, and not a required subject.

A number of colleges now recognize general science among optional subjects for which they give credit.

We hope the day is near at hand when higher institutions will recognize by suitable credit, courses which are distinctly high school courses, that is, those which are not prescribed too minutely by the college. General science is particularly free from college influence, and if college entrance credits can be given without destroying the freedom of capable teachers, well and good. If, however, college acceptance means that the college is to hand down a definite, prescribed syllabus, and thus hamper the teacher who understands the pupils' needs in a given locality better than somebody far removed from the local problem then general science will suffer, and secondary school science will suffer in consequence.

GENERAL SCIENCE NEWS.

PITTSBURGH—The new Schenley High School is well equipped for general science work. There is a lecture or demonstration room, laboratory for individual work and a recitation room. These three rooms are used only for general science classes. The laboratory is equipped for forty pupils, and there are three teachers in the laboratory at one time, with each section of forty pupils. General science is a full year subject with five periods per week. The inductive method is employed and books are used only for reference purposes. This is made possible because of the well equipped school library. The question of a text or texts is as yet undecided.

The work is in charge of W. W. D. Sones, who has been interested in general science since 1910.

The Latimer Junior High School, the first junior high school in Pittsburgh to have seventh, eighth and ninth grades in a separate building, opened in September. There are two general science rooms. General science begins in the seventh grade, takes the field of hygiene in the eighth grade, and continues as general science in the ninth grade. Mr. Graham, principal of this school, is much interested in general science and with his assistants will conduct the science work.

A committee of general science teachers representing nine high schools have drawn up a general science syllabus for use in the Pittsburgh schools. It is not yet in print and we have not seen it. On general principles we believe there is danger in such a syllabus. If the syllabus is merely suggestive and does not carry any real or implied compulsion that the teacher follow it, then it may be of real service. But, just as soon as a teacher becomes tied to a definite course, which does not consider the particular individual class with which he is at the time working, then there is danger of losing the vital touch and proper pupil reaction, which makes the difference between mediocre and excellence.

In several of the seventh and eighth grades, general science will be started this year. One great drawback to the science work in a regular seventh or eighth grade room is the lack of space for a permanent demonstration table. It is hoped that soon some apparatus house will put on the market a small, compact demonstration equipment desk on wheels, which can easily be moved into a class room and then removed at the close of the period.

PHILADELPHIA—General Science is strong in Philadelphia. The department heads in the twelve different high schools unanimously voted to introduce a general science course in all the high schools of the city. The course began in September and is called "Introduction to Science."

NEW YORK—Dr. Otis W. Caldwell, the director of the Lincoln School of Teachers College, Columbia University, will have associated with him for the general science work, Mr. Charles W. Finley from Macomb, Illinois and Mr. Earl R. Glenn, formerly of the Carter H. Harrison Technical High School, Chicago.

TRENTON—Principal Wetzel calls the applied science shop, in the Junior School, "the Tinker Shop". This is described by Mr. Miller, the shop instructor, in this issue of the QUARTERLY. Such a shop or one even less pretentious gives the pupils an opportunity to do much of the kind of work recommended by President Eliot in his plea for the development of "well-trained senses and good judgment in using them."

CALIFORNIA—"Western General Science Club" is the name of a new science club recently organized in California. Mr. Percy E. Rowell of San Jose, is president of the club.

PROVIDENCE—At the last meeting of the R. I. Teachers' Science

Association, Mr. Russell S. Lowell, of the Technical High School, was elected president.

NEW ENGLAND—At the Spring meeting of the General Science Club of New England, the following officers were elected: President, W. G. Whitman, Normal School, Salem; Vice-President, Mr. J. Richard Lunt, English High, Boston; Secretary, Mr. Geo. C. Francis, Centre School, Everett; Treasurer, Mr. Chas. H. Stone, English High School, Boston; Executive Committee, Mr. Howard C. Kelly, High School of Commerce, Springfield, Miss Edith L. Smith, West Roxbury High School, Miss Mary E. T. Healey, Sherwin School, Boston.

POSITIONS CHANGED—Mr. G. M. Ruch has accepted a position in the School of Education, University of Oregon. Mr. Percy E. Rowell is in the San Jose High School, California. This year Mr. Harry A. Richardson has changed from Kalamazoo to a Junior High school in Grand Rapids, Michigan. Mr. George M. Turner has left Buffalo and joined the teaching staff of the Boys' Polytechnic High School, Riverside, California. Mr. C. W. Lombard has gone from Leominster, Mass. to the Horace Mann School for Boys, New York.

GENERAL SCIENCE BOOKS.

General Science Teacher's Manual. Published by the State Board of Education, Boston, Massachusetts, Bulletin number 81. This is a revision of the articles published as the "General Science Bulletin" in volume I of the *Quarterly,* and may be secured free, from the Board of Education, State House, Boston.

Science for Beginners is the title of a new General Science text of 382 pages. "A First Science Book in General Science for Intermediate Schools and Junior High Schools." It is written by Professor Delos Fall, Professor of Chemistry, Albion, Michigan, and is published by the World Book Company, Yonkers, New York.